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UNITED STATES DEPARTMENT OF AGRICULTURE • Economic Research Service

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Farmland Values Reexplored

By George Iden

The selling price of agricultural land has shown an unprecedented rise over the last 25 years, due to a number of factors. Economists and real estate men have attempted to appraise the role of (1) land purchases as a hedge against inflation, (2) higher returns per acre, (3) the need for farm enlargement, (4) urban expansion, and (5) the equity position of farmers. Examples of such appraisals include those by Regan and Clarenbach *(10)*, Scofield *(11)*, and Miller *(8)*.[1] This paper tries to answer in a meaningful way the question of what has happened to the value of agricultural land on typical commercial farms and why it has happened. The author wishes to thank W. Herbert Brown and William H. Scofield for suggestions and criticisms. Edward J. Smith, Lawrence H. Shaw, and John E. Lee were helpful reviewers.

THE FIRST PART of this paper utilizes the extensive historical data on typical commercial farms collected by the Economic Research Service of the U.S. Department of Agriculture *(13)*.[2] The data for the various types of farms are generally comparable cross sectionally and over time.

The use of these data enables us to be specific with respect to the type of farmland and its location (fig. 1). Use of an average selling price for a State or region may cover up divergent price trends associated with distinctly different types of land.

The statistical analysis in the second part of this paper proposes a more quantitative technique than is often employed. Cash grain farms are used as an illustrative example. The procedure uses multiple regression to test the historical relationship between land values and the explanatory variables, expected return per acre and real per capita income of the farm population.

[1] Italic numbers in parentheses refer to items in the Literature Cited, p. 49.

[2] The concept of the typical commercial farm is analogous to Marshall's concept of the representative firm (7, pp. 317–318).

Land Values and Returns per Acre

The Value of Land

In a stationary state, where knowledge and the mobility of factors are perfect and economic activity is continuous in its present form, we would expect land value to be determined by the present value of its future earnings. And we would expect its equilibrium value to be such that the yield on investments in farmland would be the same as on alternative forms of investment.

For many reasons, the yield on capital invested in land differs from that on other investments. Variations in weather and in commodity prices cause erratic changes in the output of land. In addition, long-run trends in the economy cause some industries and some segments within each industry to grow in relative size and earnings. The value of land becomes a function of individuals' best estimates of the discounted future earnings from land relative to those from alternative investments.

The value of land is affected by many noneconomic factors as well. For example, in some regions prestige attaches to landownership as tangible evidence of position and wealth.

Nevertheless, it might be expected that the yield from capital invested in farmland would have some stability over long periods of time and that there would be a semblance of uniformity in the rates of return on capital invested in various types of farming enterprises. With these initial expectations the data on costs and returns for typical farms were examined.

Estimating the Return to Land

No completely satisfactory method for determining the earnings from farmland is available. The return to the owner-entrepreneur is for a composite of unpaid labor, land, and capital resources. The difficulties in allocating a return to each of the unpaid factors are well known (*6*, pp. 23–26, and *4*).

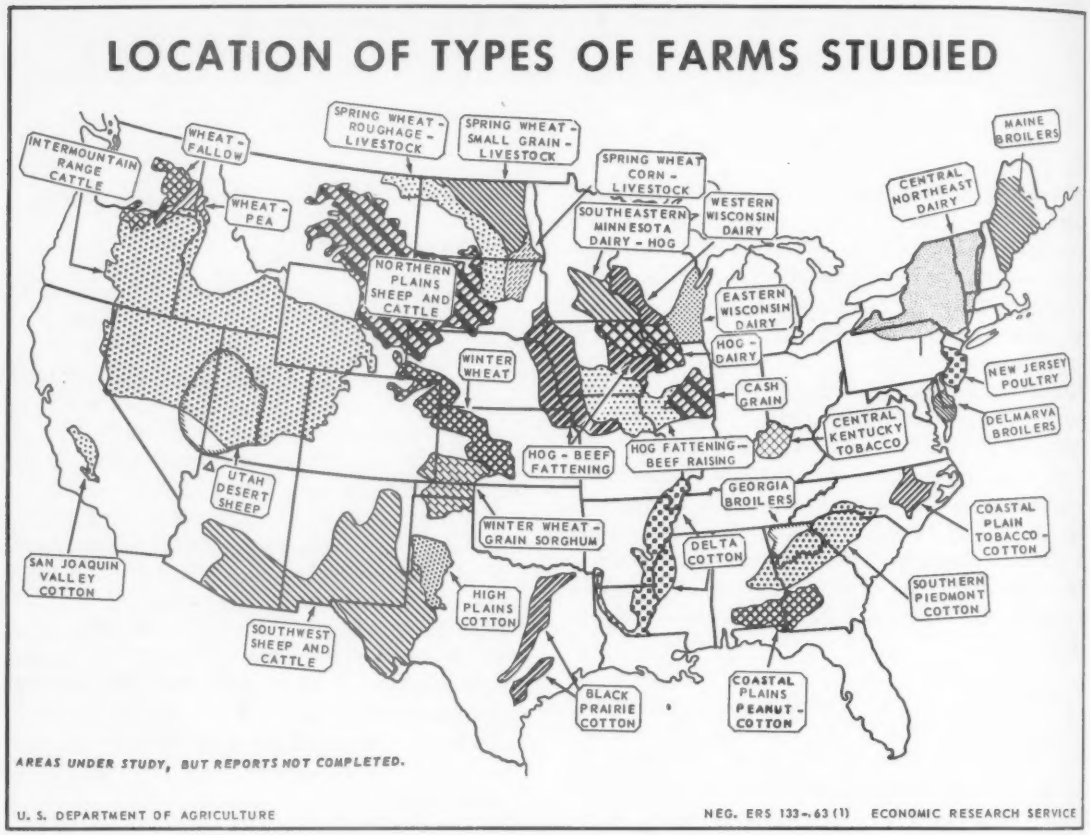

FIGURE 1

Three methods of estimating a return to land were considered. The residual method values operator and family labor at hired wage rates and non-real estate capital charges at the prevailing mortgage interest rate, with the residual imputed as a return to land. The interest rate on land was used rather than the rate charged on short-term production credit because it provided a better measure of opportunity cost.

The pro rata share method values all unpaid factors, *including* land, at hired rates. The total of these values may be more or less than net income. However, the net income is allocated to each unpaid factor in the same proportion that the imputed value of that input bears to the total imputed value of these inputs. A more detailed explanation of the pro rata share method has been presented by Hurd (*3*). Hurd uses the proportions obtained in some base period, whereas this analysis uses the proportions for each year.

The "landlord method" estimates what the land would earn if the owner rented his land on a customary rental arrangement, rather than operating it himself. The chief drawback of this method is that rental arrangements differ greatly, and data on rental practices are not very widely available.

Figure 2 compares the results obtained from each of these methods. The residual method shows returns fluctuating widely over time. Share rents show less variability, and pro rata share allocations show still less.

Because information on rental practices was available on only three types of farms, a choice had to be made between the other two methods of allocation for the analysis which follows. The residual method was selected over the pro rata

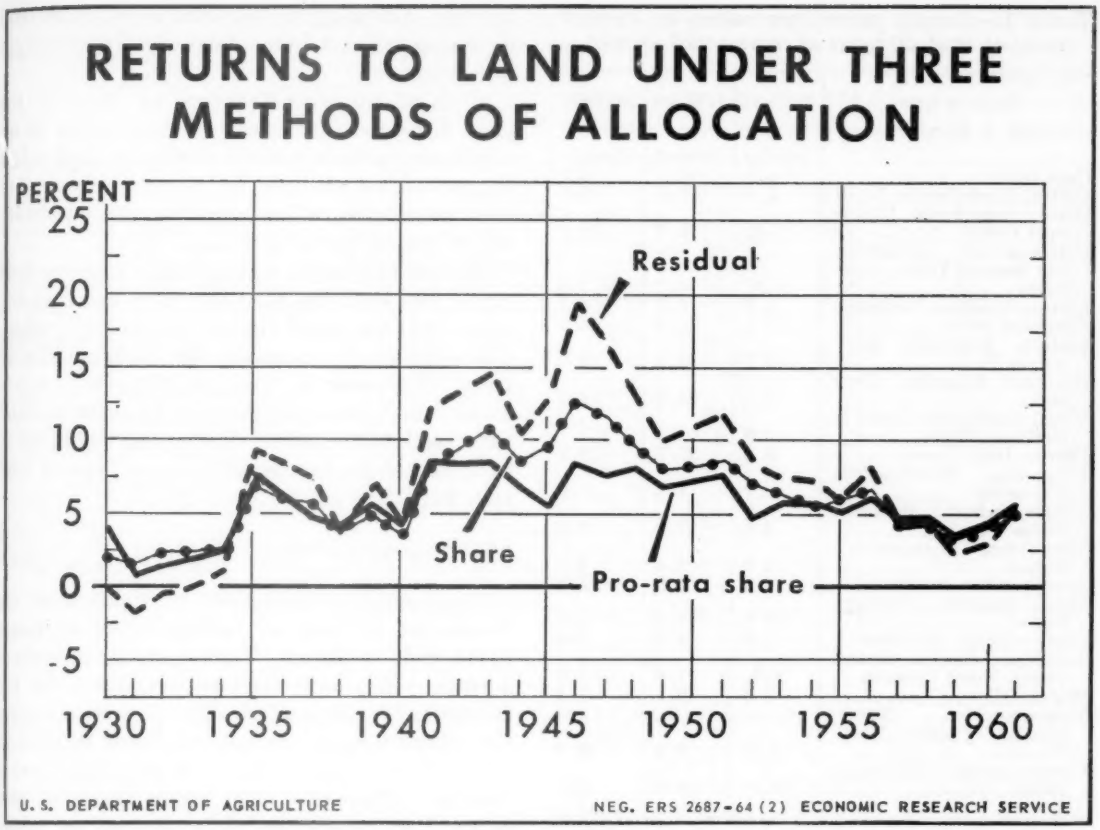

FIGURE 2

share method for two reasons. First, it corresponds more nearly to the way farmers estimate a return to land. Second, economic rent is price determined rather than price determining, and it is the difference between the supply price of a factor and its actual returns (*1*, p. 230). To the extent that nonland factors are mobile and it is possible to estimate the alternative earning capacities for nonland resources, the residual is a return to land.

The use of the residual method implies that the analysis over time for one type of farm is more valid than inference from a cross-sectional comparison of different types of farms. For example, a bias due to the use of a particular wage rate for operator and family labor is likely to be about the same over time. Thus, we may say with some assurance that the return to land for a particular type of farm was increased or decreased and that the dispersion of the return to capital invested in various types of farms was more or less in one period than in another.

The Historical View

In the 5-year period, 1937–41, most of the farms in table 1 yielded a 5 to 10 percent return on current value of the investment in land. Cash returns per acre rose during and after the Second World War and tended to reach a peak in the period 1947–49. Tables 2 and 3 show that changes in land values lagged behind changes in income so that returns of more than 20 percent on current value were realized on farms in the corn and cotton producing areas. Since the early 1950's farm income has declined; yet, values have continued to climb, driving the yield to less than 3 percent on cash grain land in the Midwest and on cotton farms in the Black Prairie of Texas.

TABLE 1.—*Annual percentage return on current value of land, 20 types of commercial farms* [1]

Type of farm	1937–41	1947–49	1957–61
	Percent	*Percent*	*Percent*
Cash grain	6.9	13.2	3.9
Cotton, Black Prairie, Texas	7.4	12.0	3.6
Cotton (large scale), Mississippi Delta	[2] N.A.	16.3	11.0
Cotton-general (irrigated), San Joaquin Valley, California	N.A.	16.3	7.3
Cotton, Southern Piedmont	5.7	6.6	4.7
Northeast dairy	5.3	16.1	4.6
Eastern Wisconsin dairy (Grade B)	−2.7	−4.4	−6.0
Hog–beef fattening, Corn Belt	9.3	22.6	4.5
Wheat–small-grain–livestock, Northern Plains	1.5	21.5	1.7
Cotton, High Plains	9.6	20.7	14.7
Dairy–hog, Southeastern Minnesota	.7	3.9	−.9
Winter wheat, Southern Plains	4.2	17.9	8.8
Wheat–pea, Washington and Oregon	8.0	11.4	5.2
Sheep ranches, Southwest	4.9	2.9	3.8
Cattle ranches, Northern Plains	1.1	8.4	1.9
Cattle ranches, Southwest	2.9	4.6	3.6
Tobacco (small), Coastal Plains, North Carolina	N.A.	11.6	7.6
Wheat–fallow	3.7	18.1	7.5
Tobacco–cotton (large), Coastal Plains, North Carolina	N.A.	9.4	6.7
Cotton (small), Mississippi Delta	N.A.	22.3	5.7

[1] Computations made from data supplied by the Cost, Income and Efficiency Branch of the Farm Production Economics Division, USDA.
[2] Not available.

Table 2 shows that value per acre on each of 20 types of farms increased substantially between 1947–49 and 1957–61. The largest increases in value have occurred on cotton–general farms in the San Joaquin Valley of California, on dairy–hog farms in southeastern Minnesota, and on small cotton farms in the Mississippi Delta. The smallest increases occurred on sheep and cattle ranches and on large tobacco–cotton farms of the Coastal Plains of North Carolina. Since 1947–49, cash return per acre (table 3) has risen on the cotton farms and on the sheep and cattle ranches, but it has fallen on the other types of farms studied. The decline has been severe on wheat–small-grain–livestock farms of the Northern Plains, Northeast dairy farms, and small cotton farms of the Mississippi Delta. In recent years, the yield on current value has been lowest on farms with declining income. This suggests that land values often tend to be sluggish and do not react rapidly to changes in farm income.

Much of the wide historical variation in the yield from the investment in land is due to an adjustment process wherein changes in land values lagged behind changes in return per acre, but eventually increased to more than compensate for higher returns per acre.

One of the major upward pressures on land prices has been the need for farm enlargement. After 1941 the rapid rate of technological adoption significantly increased the optimum size of farm. Wherever the average or typical farm is smaller than the optimum, the pressure on land value tends to be greater. Table 4 shows that farm enlargement has become a dominant type of land transfer.

The Cross-Section View

Cross-sectional comparison of yields from the investment in land on various types of farms shows wide variation. Table 5 gives unweighted average yields and standard deviations for the 20 types of farms studied. The dispersion among the types of farms studied was lower in 1937–41 and 1957–61 than in the more prosperous years 1947–49. Changes in farm income were more pronounced on some types of farms than on others and values did not rise enough to maintain a uniform yield on current value. Over time, however, values tended to approach an equilibrium so that comparative returns among regions and types of farms became more uniform for 1957–61.

A variety of factors are responsible for dispersion in returns. Urban areas, highways, airports, and reservoirs took an average of about 831,000 acres per year from 1945 to 1954 (*16*, p. 26). In some areas these nonfarm competing uses have taken more farmland than in other areas, and hence have a greater effect on the value of land.

Percentage returns on current value may be lower on some types of farms than on others because of a relative abundance of inputs other than land. Where there are few competing uses for operator and family labor, land becomes a limiting resource for the farm enterprise and the imputed value of land becomes correspondingly higher than in locations where labor and other nonland inputs are more mobile. This may partially ex-

TABLE 2.—*Land value per acre on 20 types of commercial farms* [1]

Type of farm	1937–41	1947–49	1957–61	Percent of 1947–49	
				1937–41	1957–61
	Dollars	*Dollars*	*Dollars*	*Percent*	*Percent*
Cash grain	120. 80	219. 70	376. 00	55	171
Cotton, Black Prairie, Texas	51. 90	86. 20	146. 40	60	170
Cotton (large-scale), Mississippi Delta	N.A.	84. 60	162. 20	N.A.	192
Cotton—general (irrigated), San Joaquin Valley, California	N.A.	336. 00	768. 00	N.A.	229
Cotton, Southern Piedmont	22. 80	55. 20	91. 80	41	166
Northeast dairy	30. 40	58. 00	90. 50	52	156
Eastern Wisconsin dairy (Grade B)	79. 30	118. 70	174. 40	67	147
Hog-beef fattening, Corn Belt	79. 20	152. 70	253. 00	52	166
Wheat-small-grain-livestock, Northern Plains	16. 60	27. 30	46. 20	61	169
Cotton, High Plains	37. 06	78. 01	116. 20	48	149
Dairy-hog, Southeastern Minnesota	63. 44	98. 67	193. 80	64	196
Winter wheat, Southern Plains	28. 00	64. 00	95. 00	44	148
Wheat-pea, Washington and Oregon	66. 04	174. 70	267. 62	38	153
Sheep ranches, Southwest	5. 77	9. 97	12. 31	58	124
Cattle ranches, Northern Plains	3. 54	8. 77	11. 07	40	126
Cattle ranches, Southwest	4. 20	8. 56	10. 56	49	123
Tobacco (small), Coastal Plains, North Carolina	N.A.	135. 00	200. 00	N.A.	148
Wheat-fallow	19. 51	43. 56	82. 92	45	190
Tobacco-cotton (large), Coastal Plains, North Carolina	N.A.	139. 66	183. 80	N.A.	132
Cotton (small), Mississippi Delta	N.A.	84. 03	163. 80	N.A.	195

[1] Computations made from data supplied by the Cost, Income and Efficiency Branch of the Farm Production Economics Division, USDA.

TABLE 3.—*Cash returns per acre on 20 types of commercial farms* [1]

Type of farm	1937–41	1947–49	1957–61	Percentage of 1947–49	
				1937–41	1957–61
	Dollars	*Dollars*	*Dollars*	*Percent*	*Percent*
Cash grain	8. 33	28. 92	14. 65	29. 0	51. 0
Cotton, Black Prairie, Texas	3. 85	10. 34	5. 27	37. 2	51. 0
Cotton (large-scale), Mississippi Delta	N.A.	13. 75	17. 79	N.A.	129. 4
Cotton—general (irrigated), San Joaquin Valley, California	N.A.	54. 92	55. 85	N.A.	102. 0
Cotton, Southern Piedmont	1. 30	3. 65	4. 32	36. 0	118. 4
Northeast dairy	1. 62	9. 35	4. 17	17. 3	44. 6
Eastern Wisconsin dairy (Grade B)	−2. 15	−5. 18	−10. 45	(*)	(*)
Hog—beef fattening, Corn Belt	7. 40	34. 54	11. 34	21. 4	32. 8
Wheat—small-grain—livestock, Northern Plains	. 25	5. 88	. 79	4. 3	13. 4
Cotton, High Plains	3. 57	16. 15	16. 97	22. 1	105. 1
Dairy—hog, Southeastern Minnesota	. 41	3. 81	−. 37	10. 8	(*)
Winter wheat, Southern Plains	1. 17	11. 48	8. 32	10. 2	72. 5
Wheat—pea, Washington and Oregon	5. 31	20. 01	13. 89	26. 5	69. 4
Sheep ranches, Southwest	. 28	. 29	. 47	97. 0	162. 1
Cattle ranches, Northern Plains	. 04	. 74	. 21	5. 4	28. 4
Cattle ranches, Southwest	. 12	. 39	. 38	30. 8	97. 4
Tobacco (small), Coastal Plains, North Carolina	N.A.	15. 60	15. 10	N.A.	96. 8
Wheat—fallow	. 73	7. 90	6. 19	9. 2	78. 4
Tobacco—cotton (large), Coastal Plains, North Carolina	N.A.	13. 13	12. 24	N.A.	93. 2
Cotton (small), Mississippi Delta	N.A.	18. 72	9. 34	N.A.	49. 9

[1] Computations made from data supplied by the Cost, Income and Efficiency Branch of the Farm Production Economics Division, USDA.

*The indicated comparison does not apply as it is not meaningful to speak of a reduction in loss in the same manner as an increase in return starting from a positive return.

TABLE 4.—*Percentage of farmland purchases for farm enlargement, United States*

Year	Percent
1950–54	26
1958–59	42
1959–60	45

Source: Farm Real Estate Market (*15*, p. 3).

TABLE 5.—*Mean rate of return on investment and standard deviation for 20 types of farms*

Years	Mean	Standard deviation
	Percent	*Percent*
1937–41	4.6	3.4
1947–49	12.6	7.2
1957–61	4.9	4.1

plain why percentage returns from land are low on Wisconsin dairy farms, and why returns on Southern Piedmont cotton farms are lower than those on cotton farms in the San Joaquin Valley (table 1).

On the other hand, where there are many alternative opportunities and the shift from agricultural to nonagricultural employment is proceeding at a rapid rate, there is a different kind of upward pressure on land values. Capital from off-farm employment is often funneled into farm capital, and higher land prices result. Farms are also valued as rural residences by both farm and nonfarm people. The high cost of housing in towns and cities influences the price of small farms with rural residences and in turn the value of larger farms.

The highest percentages of land transfers for the purpose of farm enlargement have occurred in the Corn Belt and wheat areas, where the trend toward mechanization has been most pronounced in recent years (table 6). The lowest percentages have occurred in the dairy and general farming regions where large-scale mechanization has not been as much in evidence. Pressure on land values due to farm enlargement is likely to be greater and, ceteris paribus, the yield from investment in land would tend to be lower in the corn and wheat areas than in the dairy and general farming areas.

Statistical Test of the Hypothesis

We have assumed that farmland value is determined by individuals' best estimates of the future returns per acre from farming accruing to a landowner, and by the level of per capita personal income, especially of those persons interested in becoming landowners. Since there is no objective measure of what people expect returns from land to be in the future, this analysis takes as an indication a 3-year moving average of returns per acre with income in recent years weighted more heavily.

Farmland may be purchased in hopes of gains in equity. However, expected capital gains cannot keep the price high forever. In a period when the expectation of capital gains has had a pronounced effect on the price of land we may say that a change in structure has occurred between returns per acre and land values.

TABLE 6.—*Percentage of total farmland sales for farm enlargement, selected type-of-farming areas and United States, average 1950–54 and annual 1956–60*

Type of farming area	Average 1950–54	1956	1957	1958	1959	1960
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Northeast dairy	14	14	18	24	22	21
Lake State dairy	16	21	26	22	28	31
General farming	19	20	23	25	26	29
Eastern Corn Belt	29	41	45	46	50	55
Western Corn Belt	28	38	43	46	47	52
Wheat areas	48	57	64	65	66	59
Western cotton	30	34	43	49	59	46
Western range livestock	31	38	39	48	48	49
United States	26	33	38	40	42	45

Source: Farm Real Estate Market (*15*, p. 13).

Farmers' ability to pay may be expected to affect land prices for several reasons. First, a farmer's earnings and equity position are important factors determining his willingness and ability to obtain a loan and buy a farm.

Second, each generation is faced with the necessity of buying or renting a farm, or changing occupations. There are well-known difficulties in renting land. Nearby land may be unavailable. The interests of landlord and tenant may conflict. Uncertainty as to the duration of the tenure arrangement is another disadvantage in renting land. Under these circumstances, landownership becomes an important goal in itself, and a significant part of per capita farm income is likely to be used in achieving this goal.

Third, farm families with investment funds may lack sufficient knowledge of the market to seek higher returns in other industries. L. F. Miller (*9*) found strong preferences among Pennsylvania farmers for holdings in farm and nonfarm real estate and Government bonds. In the assets outside the farm business there was little diversification. Because of the strong preference for land over other forms of investments, investable funds (ability to pay) may be expected to have more impact on land prices than on, say, stock and bond prices.

Per capita farm income from all sources is used as the measure of farmers' ability to pay. No such measure is available for farmers in Illinois or the Corn Belt, so we were forced to use the national average in the hope that it would reflect trends in ability to pay of farmers located in the geographic area. Unfortunately, the national average includes many farmers who could not be considered as part of the market for Illinois farmland. In addition, it does not reflect changes in ability to pay of many nonfarmers in the local area who *are* a part of the market for Illinois farmland.

The Data

Data on cash-grain farms in Illinois were selected for a statistical test of the hypothesis (table 7). In estimating returns attributable to land and buildings the landlord method was used instead of the residual method. The normal renting arrangement for Illinois cash-grain farms is for the landlord to take half of the crops, pay upkeep on the land and buildings, and share equally in seed, fertilizer, and pesticide expenses. In computing the moving average of the landlord's net returns per acre a weight of 3 was given to year t, 2 to year $t-1$, and 1 to year $t-2$. The other independent variable, per capita personal income from all sources, was deflated by a price index composed of items purchased by farm families for family living (*14*, p. 43).

There was no reason to deflate either the historical value or the returns-per-acre figures, as this would remove part of the relationship to be tested, i.e., the response of land values to trends in commodity prices and crop yields. Deflating the

TABLE 7.—*Land values and returns to land, Illinois cash grain farms, and income of potential buyers, 1934–50*

Year	Value per acre	Weighted moving average of returns per acre	Per capita personal income of U.S. farm population[1]
	Dollars	*Dollars*	*Dollars*
1934	97	2. 38	136
1935	99	4. 53	194
1936	106	5. 85	183
1937	114	6. 50	224
1938	120	5. 53	190
1939	118	5. 52	200
1940	125	4. 85	207
1941	127	7. 55	257
1942	141	10. 75	325
1943	146	14. 02	376
1944	169	17. 67	380
1945	176	15. 83	385
1946	181	19. 45	391
1947	206	22. 38	343
1948	222	22. 33	384
1949	231	20. 16	324
1950	236	19. 27	356
1951	278	21. 48	389
1952	299	21. 66	378
1953	310	20. 83	375
1954	304	18. 40	370
1955	309	17. 94	356
1956	324	19. 74	362
1957	352	17. 69	378
1958	370	16. 72	417
1959	394	14. 24	397
1960	394	15. 08	433
1961	370	16. 57	472

[1] Deflated for changes in the prices of commodities bought for use in family maintenance. See the farm consumers' price index found in *Agricultural Statistics* (*12*).

per capita income series gave a measure of ability to pay in real terms.

Fitting a Multiple Regression Equation

From 1934 to 1950 all three variables showed strong upward trends; but after 1950 land values continued to climb while returns per acre declined. Per capita income declined in the middle 1950's, to rise again in the latter 1950's and early 1960's.

Several explanations can be offered for the structural change occurring after the break in farm prices in 1951–52. Most important were technological advances which increased the optimum size of farm and created pressures for farm enlargement. Second, many persons probably believed that the Government would continue to support agricultural prices. Third, many believed that urbanization and population growth made agricultural land an excellent long-term holding and hedge against inflation.

Because of the evident structural change occurring after the decline in farm prices, the 17-year period 1934–50 was selected for analysis.

The following linear form was postulated:

$$Y_t = A + B_1 X_{1t} + B_2 X_{2t} + U_t$$

where Y_t = value per acre

X_t = moving average of cash returns per acre attributed to land

X_{2t} = per capita income (from all sources) for the U.S. farm population

U_t = unexplained influence (assumed to be random).

The data gave the following equation:

$$Y_t = 36.9 + 0.50 X_{1t} + 0.39 X_{2t}$$

This regression equation had a coefficient of determination of 0.66. However, there was an indication of strong autocorrelation among the residuals.[3] Thus, the estimate might still be unbiased and consistent, but it would not be the most efficient or the most likely estimate. The R^2 and tests of significance would be meaningless (*5*, p. 179).

The autoregressive scheme was estimated, and the data were transformed using the following relationship:

$$Y'_t = Y_t - 0.75 Y_{t-1}$$

$$X'_{1t} = X_{1t} - 0.75 X_{1t-1}$$

$$X'_{2t} = X_{2t} - 0.75 X_{2t-1}$$

We then reapplied ordinary least squares and arrived at the equation:

$$Y'_t = 34.19 + 4.80 X'_{1t} - 0.08 X'_{2t}$$
$$\qquad\qquad (1.68) \qquad (.101)$$

The Durbin-Watson statistic (*2*), a test for autocorrelation in the disturbances, was significantly improved but was still in the indefinite range. The R^2 was 0.42, which indicated that variations in X_{1t} and X_{2t} about their means "explained" 42 percent of the squared variation of Y'_t about its mean.

Statistical Significance of the Results

The variable X'_{1t} was significantly different from zero at the 95 percent confidence level, indicating that there was a linear relationship between changes in return per acre and value per acre.

Analysis of the X'_{2t} variable gave surprising results. Its influence on Y'_t was insignificant. In the regression equation we expected the sign of this coefficient to be positive instead of negative. The negative value implied that, ceteris paribus, an increase in per capita income is associated with a decline in land value. This suggestion may result from an inability to effectively measure the purchasing ability of the farm people who are potential buyers of land in the area. In addition, the result is partially due to multicollinearity among the explanatory variables.[4] We chose the independent variable with the higher simple correlation coefficient and obtained the equation:

$$Y'_t = 29.90 + 4.15 X'_{1t}$$
$$\qquad\quad (5.91) \quad (1.37)$$

[3] One of the necessary assumptions for the ordinary least squares estimating procedure is that the residual of one period is independent of the residual in any previous period. The absence of this convenient characteristic is called autocorrelation.

[4] Multicollinearity is the problem which arises when two or more explanatory variables are highly correlated relative to their respective simple correlations with the dependent variable. When this is the case it is impossible to disentangle the separate influence of the independent variables.

This regression equation has an R^2 of 0.40. These results imply that a change of one dollar in the moving average of return per acre is associated with a change of $4.15 in land values. This response of land values to a change in returns per acre is highly significant but the magnitude is not as great as anticipated.

A Summing Up

The time series analysis reveals wide variations in yields on investments in farmland. Returns to land rose rapidly in the 1940's, but land values showed little response. More recently, land values have caught up with returns, and yields have declined to former levels.

Similarly, in cross section there was a wide dispersion of yields from the investment in land among types of farms. Though some of this dispersion was due to the method of computing returns per acre, not all of the variation can be explained in this way. In some areas nonland production factors are less mobile than in other areas, causing the value of land to be bid up, and the opportunity cost of nonland resources to be lower. The trend toward increasing size is more in evidence for some types of farms than for others. Next, there are demographic and institutional factors that affect whole regions. Lastly, neither capital nor farm operators appear to be highly mobile in seeking out the types of farming and areas where returns are highest.

The attempt at a quantitative analysis of factors determining land values was only partially successful, but served to point out a lack of association between land values and real per capita personal income of the farm population. However, the association between land values and returns per acre was statistically significant. Relationships were tested on only one type of farm (cash-grain), and over a limited period of time, 1934 to 1950. One criticism of the approach might be that the time period was picked. An answer to this objection is that the same explanatory variables are not applicable in all periods, and it is the job of the researcher to choose the most relevant variables for particular time periods.

It would be helpful if studies of agricultural land values could utilize data with a wider coverage, and go beyond a listing of factors responsible for changes in land value to an attempt to quantify these influences. Finally, the implications of the trend toward larger farms need to be examined. Perhaps data on costs and returns for typical farms might be utilized to compute a synthetic variable, "economic advantage to be gained from farm enlargement."

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Economic Growth and the Theory of Agricultural Revolution

By Joseph A. Swanson

The role of the agricultural sector in economic growth has recently come under study. Numerous articles have appeared on the theoretical aspects (capital formation, increased productivity, etc.) of agriculture's contribution as well as on the numerical magnitude of changes that have taken place. These studies, together with many historical writings on the growth of American agriculture, raise the possibility of several hypotheses about the specific role of agriculture in American economic growth. Recently the work of Rasmussen *(9)* has presented a hypothesis which deserves examination.[1] Rasmussen finds that the statistical record shows two periods of "revolutionary" change in the agriculture sector: 1850 to 1870 and 1940 to the present time. He notes that these were periods of radical changes in the sources of farm power; they appear as periods of sharp increases in both output and productivity. Specific changes in technology and the nature of demand are shown to have had given effects on the nature of production; hence, upon the structure of the sector. This article examines the theory underlying the concept of "agricultural revolution." That is, the usage of this term, previously and presently, is examined in the light of recent work in the field of development theory and economic history.

AGRICULTURAL HISTORIANS have developed numerous constructs of an agricultural revolution—nearly all of which contradict one another with regard to timing.[2] Schmidt *(12)* represents the viewpoint of most of these authors. He writes of a "triple economic revolution," marked by the commercialization of agriculture, mechanization of industry, and internationalization of the market—a revolution of 70 years' duration, from 1860 to 1930. Schmidt goes on to isolate causes of the revolution in agriculture: (1) the passing of public lands into private ownership; (2) rapid growth in population and immigration; (3) invention and popularization of improved farm implements and machinery; (4) extension and development of transport facilities; (5) migration of industries from farm to factory; (6) expansion of foreign and domestic markets; and (7) the establishment of agencies for the promotion of scientific knowledge relating to agriculture.

Rasmussen's emphasis upon the changing nature of production relationships puts the problem of defining agricultural revolution in another light. To understand this position we must turn to an analysis of the manner in which output levels are attained. The level of output depends on the existence of given technical relationships (parameters) in the system. The mechanism by which changes in these parameters take place offers a definition of the concept of "agricultural revolution."

Sources of Change in Level of Output

To consider the movement of output through time we need a function which relates the outputs of the agricultural sector to its inputs. In view of our interest in technical change we begin with a production function similar to that developed by Solow *(13)*:

$$O=A(t)(x_1, x_2, \ldots, x_n) \tag{1}$$

where O=output; $A(t)$=a scalar, expressed as a function of time to represent technical change; and $(x_1, x_2, \ldots, x_n)$=a vector of n inputs. For purposes of exposition we will assume that these n inputs may be aggregated so that:

$$X=\sum_{i=1}^{n} x_i. \tag{2}$$

Or, X is equal to the sum of all production inputs. Since we hold, like Solow, that any technical change that takes place is "neutral," the aggregation of these inputs is not a limiting assumption.[3] Further, it must be assumed that the

[1] Italic numbers in parentheses refer to items in the Literature Cited. p. 56.

[2] See Rasmussen (*9*) for a presentation of this group of writers.

[3] Solow's assumption that technical change is "neutral" means that it is not associated with any given input, but rather with their totality.

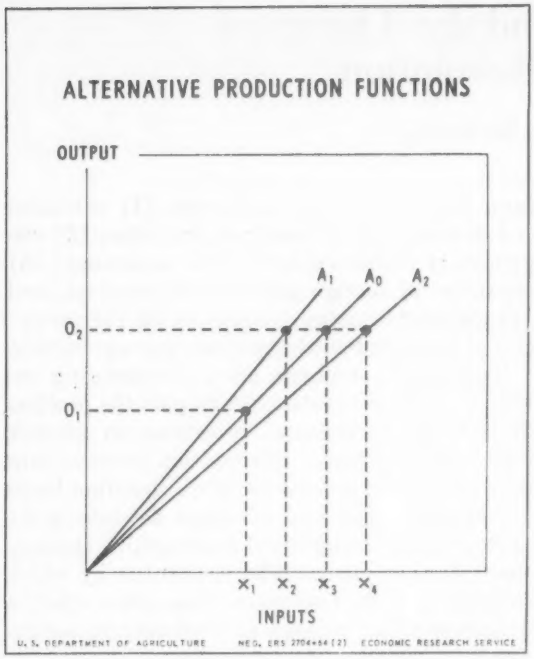

FIGURE 1

ratio of any input (x_i) to any other input (x_j) remains constant through time, i.e., $x_i/x_j=k$ for all i and j.

A production function may be specified as

$$O_t=A_0X_t. \tag{3}$$

As the subscripts refer to time, output in the tth time period is a linear function of the inputs used in that time period. Inputs are transformed to outputs by a given technical coefficient of production, A; in this case the coefficient A_0. Such a function is presented graphically in figure 1.

In this figure output (O) is given on the y-axis and inputs (X) are given on the x-axis. The technical coefficients of production (A's) are shown as the slopes of lines which connect the x-y intercept with points of optimum output. The subscripts of the A's in figure 1 indicate time.

Output in the first time period (O_1) is the result of the production function

$$O_1=A_0X_1. \tag{4}$$

We may increase production to O_2 by using one of the three following production functions:

$$O_2=A_1X_2 \tag{5}$$

$$O_2=A_0X_3 \tag{6}$$

$$O_2=A_2X_4. \tag{7}$$

The level of output depends on the level of inputs and on changes in the technical coefficient of production. What we are interested in here, however, is not the means of raising output, but rather the changes which the historical record shows have taken place in input-output relationships. We make use of figure 1, then, to see how closely each of the possible relationships approximates the record of previous development.

The hypothesis to be developed here is that changes in agricultural output in the United States have been due to variations in the ways of combining inputs.[4] For example, the production function

$$O_2=A_1X_2 \tag{5}$$

describes the source of output growth in recent decades; a similar phenomenon occurred in 1850–70. With reference to our initial production function (1) we find that the derivative of technical change with respect to time is greater than one, or:

$$\frac{dA(t)}{dt}>1.$$

Stated another way, output has increased at a faster rate than total input:

$$\frac{O_2-O_1}{O_1}>\frac{X_2-X_1}{X_1}.$$

If no change in the technical coefficient (A) occurs, O_2 may be produced by using quantity X_3 of total inputs. Thus the relevant production function is:

$$O_2=A_0X_3. \tag{6}$$

Output has now changed at about the same rate as input:

$$\frac{O_2-O_1}{O_1}=\frac{X_3-X_1}{X_1}.$$

[4] The data used to examine this hypothesis are provided by Towne and Rasmussen (*16*), Loomis and Barton (*8*), and Gallman (*3*).

Returning to our initial production function we find the derivative of technical change to be as follows:

$$\frac{dA(t)}{dt}=1.$$

This situation is not unlike the changes which occurred during the decades 1880–90 and 1900–10.

Finally, we may detect decades in which output is increasing at a slower rate than input. For such periods we use the production function

$$O_2=A_2X_4 \tag{7}$$

as a likely description. For the decades 1870–80 and 1910–20, we have such a proportionate change:

$$\frac{O_2-O_1}{O_1}<\frac{X_4-X_1}{X_1},$$

and a derivative of our initial production function (1):

$$\frac{dA(t)}{dt}<1.$$

Thus, having observed the means by which alternative output levels can be measured and the relationships which these alternatives have with the actual data, we may go on to describe the mechanism of technological change.[5]

Let one more piece of exposition be made by use of figure 1: that the proportionate changes in inputs and output are significant to the analysis of the growth of the agricultural sector. Specifically, let us state that when output growth coincides with a similar, or greater, rate of growth in the volume of input, *extensive* change has taken place in the sector. Under extensive change we may merely be reproducing a given production situation—as was the case of producing the output (O_2) with the production function (6); we did not change the technical coefficient (A_0), but merely the inputs used. Similarly, we achieved the output (O_2) by using production function (7) which implies a less efficient use of inputs.

Salter (*11*) distinguishes "extensive" growth from "growth in depth." In the latter case we have used less input to produce a greater output—as in producing the output (O_2) by use of the production function (5). "Growth in depth" might be called *intensive* growth.

The movement of the scalar $A(t)$ is the most significant factor in each type of growth; it represents the effect of technical change on the input combinations. We must now raise the questions which bear upon the movement of this coefficient. Let us consider intensive growth in output to be of a "revolutionary" nature and discuss the process of technical change in such growth.

Sources of Technical Change

If we consider only *intensive* shifts in output as being revolutionary, it is necessary to isolate the sources of the shifts. Factors accounting for shifts in the technical coefficient—or, more generally, shifts in productivity—are: (1) changes in the institutional and dimensional structure of the economy; (2) economies of scale that exist at differing periods; (3) changing capacity (or educational levels) of the labor force; and (4) the level of technical knowledge and the nature of its application. Following the chemist's notation, we might write that the reaction of technology and economies of scale is catalyzed by the capabilities of the labor force and the structure of the economy and that this process yields increased output.

In analyzing the role of these productivity-increasing factors, let us first discuss the reactants: economies of scale and technological change. "Economies of scale" is a term used to describe the downward movement of short-run average cost curves over time. It is an economic condition. Conversely, pure technological change is a noneconomic condition. It reflects only the level of the industrial arts within the economy, i.e., the state of technical knowledge, its application to the production process, and the extent of its adoption (*2*, pp. 142–143).

The distinction between economic and noneconomic parameters is that made by Haavelmo (*4*): the former bear specifically on a sector's physical output; the latter contribute only indirectly to output. It should be noted that noneconomic parameters are determined by the movements of economic variables. Clearly, economic decisions rest on each of these conditions and are not exclusive to one or the other.

Of the catalysts designated above, structure and capacity of the labor force, we define the former

[5] By technical change we mean those factors which affect the input-output ratio, creating more or less efficient utilization of inputs. *Technical change* is distinct from *technological change*, which represents variations in the state of the industrial arts.

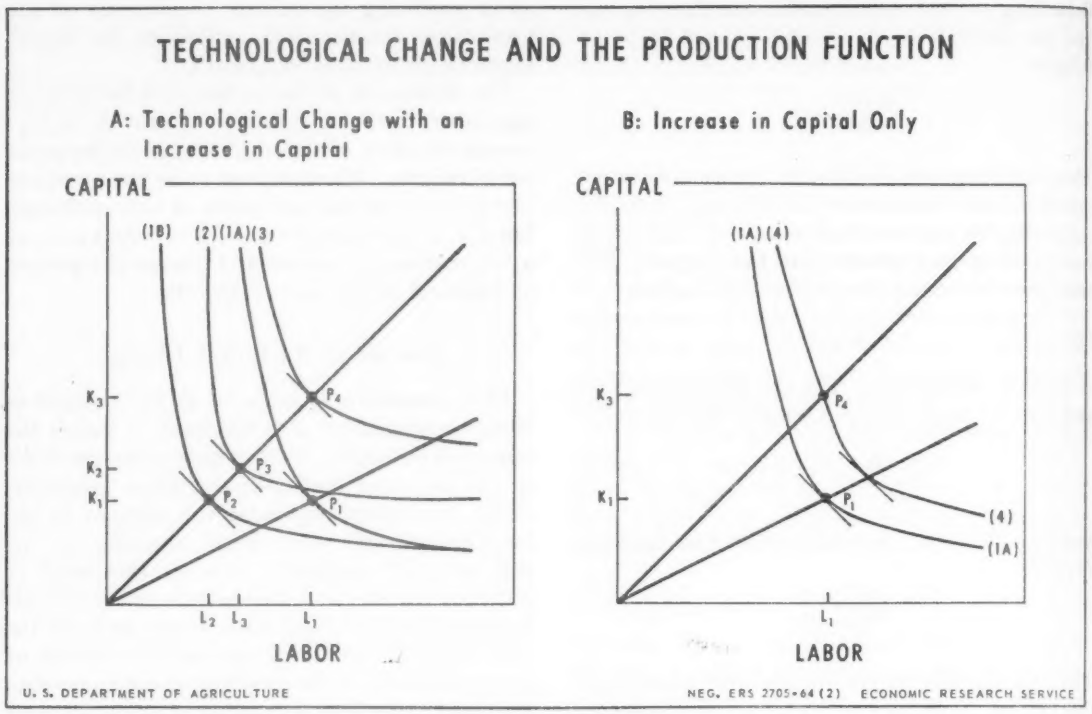

FIGURE 2

as an economic and the latter as a noneconomic parameter. While these catalytic agents are given here as sources of output growth, they may also be considered as constraints on output growth. The intricate concurrences of these agents is apparent; they are separated here only for purposes of comprehension.

In considering the possibilities of input-output combinations, we discussed "neutral" technical change. This was analogous to shifts in the production function, which do not change the marginal rates of substitution of any of the factors but merely increase output attainable from given factor inputs. We may also have "slope" technical change, where our production function is:

$$O = f(x_1, x_2, \ldots, x_n; t). \tag{8}$$

Since "slope" changes involve new sets of marginal substitution rates, they are critical to our analysis; they represent technological change within technical change. Changes of technical nature involving "slope" changes are not so easily grasped, for they concern the interaction of capital and technological change.

A method presented by Resek allows us a clearer presentation of this matter (*10*, pp. 56-57). In figure 2A we begin by considering isoquant 1. This isoquant is split into 1A and 1B: the 1A curve gives an initial production function, and the 1B curve indicates that function after the adoption of a capital-saving innovation. If we allow (total) inputs to remain unchanged, isoquant 2 evolves (i.e., inputs shift from K_1L_1 to K_2L_3). Further, if the price ratios [6] are constant, production point p_4 on isoquant 3 can be reached. Alternatively, production point p_4 could be reached by expanding the initial isoquant 1A out to form isoquant 4—without changing factor proportions in the production function. This is done in figure 2B.

If, then, we give the initial output (isoquant 1A at point p_1) as 100 units and production at point p_2 as the same, the outward (linear) shift caused by employing the same total inputs gives a 30 percent increase in output; the total output at p_3

[6] These are given by the lines sloping northwest-southeast in figures 2A and 2B.

is 130 units. Expanding to isoquant 3, production at point p_4 becomes 180 units. Again, shifting isoquant 1A to isoquant 4 by increasing the capital input singularly (15 percent) we raise output to 115 units. The total increase in output, 80 units, is the result of a 30 percent increase in technical change, a 15 percent increase in capital, and a 35 percent increase in the interaction of capital and technology.[7]

In summary, "neutral" technological change is that which involves only shifts based on scale changes with marginal rates of substitution remaining constant. "Slope" changes are, conversely, those involving a new set of marginal substitution rates; they have the character of innovation. And the types of innovations which are made are related to input availability within the economy or sector. To achieve a broader view of the innovation process—particularly within the framework of the "agricultural revolution"—we must examine the existing relationships which create such shifts in the production function.

Causes of Technical Change

Turning from the consideration of *sources* of changes in output, we examine a more complex concept, that of *causes* of changes in output. Three dynamic factors in the history of the agricultural sector may be given: the growth of population, changes in the character of demand, and technological change. These factors are interdependent (*5*, pp. 255–258). We need not concern ourselves with the determinants of these factors; abundant literature exists on their nature. Rather, let us examine the role of these factors in the growth of a given sector.

Increases in a country's population give rise to a number of changes in the structure of the country's economy; savings, input availability, and per capita income are examples. We may take per capita income as a variable which will be instrumental in the development process.[8] In an economy experiencing increases in total population a similar increase in total production is observed. However, the source of this increased production—improved economic organization, due to the pressures of population growth—is limited by resource availability. The latter may result in decreased per capita production, unless innovations which save factor inputs are adopted. The character of the resultant innovations depends on the nature of demand and on the availablity of inputs and production techniques. This need not imply a narrow approximation of historical events; it offers an approximation of the interrelation of population and resources in the growth process.

Spengler shows the relationship of a population-resources mix to final production as governed by technology and demand (*14*, p. 137). Technological change is the producer's means of dealing with alternative population sizes and resource availability, while demand change is the consumer's means of adapting to the same alternatives. It follows that variation in population and resource availablity gives rise to changing technology and demand.

Conclusion

The changes in production functions over time do not go a great distance in helping us to understand our growth experience. We have a multiplicity of factors involved, which are not explained by the concept of "agricultural revolution." For example, what relationships do the movements of production functions we have discussed have to the "long swings" found by Abramovitz (*1*) and Kuznets (*6*)? Or, what can be said of the changing nature of production with reference to changes in population, labor force, and standards of living in the whole economy and the agricultural sector?

The concept of "agricultural revolution" has been recently used to clarify certain aspects of changes in the structure of the agricultural sector through time. Rasmussen's work (*9*) has provided a useful approach to the understanding of these changes. Certainly, this work has aptly described the changes in American agriculture for the period since 1940. What of the "first agricultural revolution," dated 1850–70? While we lack detailed data for this period, crude measures of capital and labor inputs can be constructed. And such measures used as divisors for existing output data suggest rapid technical change in this period. Thus, both periods, 1850–70 and 1940–61, have

[7] These numbers are arbitrary and similar to those used by Resek (*10*).

[8] Per capita income (or product) is most commonly used as the index of economic development. Presented here is a form of the "income-optimal" population theory, discussed by Spengler (*14*) and restated by Leibenstein (*7*).

witnessed revolutionary technical change; i.e., output advanced at a rate much greater than the change in input levels. Although wide variations exist in our estimates of technical change, these two periods may be readily singled out for their dissimilarity with other periods. However, questions about the nature of agriculture in the process of economic growth remain numerous. The study of the historical record can do much to answer these questions.

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Book Reviews

No Need for Hunger

By Jonathan Garst. Random House, New York. 182 pages. 1963. $3.95.

JONATHAN GARST has written an exciting little book with a mission. The mission is—to convince informed laymen and social leaders that there is *No Need for Hunger*. We now have the skills and the technology in the world to produce all the food that is needed now and in the next several decades—even taking into consideration the population explosion.

Mr. Garst does not develop his argument in terms of statistics, or scientific formulas or the history of nations. He tells the story of the advance in science and technology in terms of the Garst farm at Coon Rapids, Iowa. As he says, "In 1915 Thomas Jefferson would have felt much at home on the farm at Coon Rapids . . . " The crops were about the same; the farm implements were bigger but they were still pulled by horses; and the farming processes of planting, cultivating, and harvesting were little changed.

But the tractor, hybrid-seed corn, nitrogen fertilizer, the soybean, urea, and the corncobs turned the Coon Rapids farm upside down in 45 years—changing it from a tradition-bound, land-based, peasant operation to an explosive, highly productive, food-producing factory. And this, Mr. Garst argues, these same technologies can do for the underdeveloped world—if we, the skilled, will carry these technologies to the unskilled with persistence, wisdom, and some emptying of our pockets.

Mr. Garst's program of action is a bit superficial. It is built around four human types: the scientist, the business man, the salesman, and the farmer. The role assigned to the salesman both in the American development experience and in the present-day "underdevelops" is an interesting one. The extension type is not likely to find it to his tastes.

Finally, Mr. Garst ends his book with a travelog through several underdeveloped countries. The Garstian view is always fresh as he breezes from one underdeveloped country to the next. A big dash of nitrogen fertilizer and the right combination of local incentive and foreign technical assistance form the usual development prescription.

No Need for Hunger is a wonderful tonic; it should be required reading for every tired economist and development specialist. But unfortunately the problems to which it is addressed are tougher than the author implies.

Willard W. Cochrane

Food: One Tool in International Economic Development

By Iowa State University Center for Agricultural and Economic Adjustment. Iowa State University Press, Ames. 183 pages. 1962. $4.75.

TWENTY-FOUR leading authorities on technical assistance and world food needs contributed chapters to this summary of programs, policies, and problems in world food production and distribution. The actual and potential contributions of U.S. colleges and universities, the Department of Agriculture, the Agency for International Development, international agencies, and private enterprise to world agricultural development are critically examined. Several of the authors cite as a major bottleneck in agricultural development the rather limited economic and social research on the subject and the even more limited dissemination and application of the results.

The authors raise many cogent questions such as: Is food aid a long-term help or hindrance to underdeveloped countries? Can scientific technology be transplanted? Can research on the problems of underdeveloped countries be successfully prosecuted in the United States? Should the Federal Government take more responsibility for in-

ternational programs in the agricultural colleges of the land-grant universities?

The authors' answers to these and similar questions call for sweeping changes in the orientation of U.S. agricultural research and educational institutions. Some recommendations, such as that of Loren Soth that the Federal Government take over the agricultural colleges of the land-grant universities, are highly controversial. The final chapter gives highlights from the views of each of the contributors.

Jane M. Porter

The Dilemma of Mexico's Development

By Raymond Vernon. Harvard University Press, Cambridge. 226 pages. 1963. $4.95.

THIS IS AN EFFORT to evaluate the roles and interrelationships of the public and private sectors in the growth of Mexico's economy over the last several decades. Findings are interpreted in terms of alternative potentials for growth in the future. The author gives explicit recognition to the difficulties of such an undertaking, emphasizing both the complexity of the topic and the subjective and qualitative nature of much of the interpretive analysis.

A study of the Mexican case is justified on the basis that (1) Mexico is a nation in the true sense of the word, not a collection of loosely joined localities, (2) it has a well-developed public sector and a firmly established indigenous private sector, and (3) both sectors have played vigorous roles in the country's economic growth.

The author traces the country's political course from regional separatism, revolving around a local patron, leader, or protector, to the strong central government of today with its concentration of apparent power in the office of the President. He emphasizes that the process was not attained without cost. The succession of recent Presidents worked themselves into a political straitjacket in their efforts to achieve unanimity of popular support by being responsive to every source of power in the country—including any significant elements of opposition and extending the full 180 degrees to both right and left. As a result Vernon sees the President in the 1960's as "held to a course of action which is zigzagging and vacillating when it is not blandly neutral."

Too, the government has worked itself into a key role in motivating economic growth. "It governs the distribution of land, water and loans to agriculture; it mobilizes foreign credits and rations the supply of domestic credit; it imposes price ceilings, grants tax exemptions, supports private security issues, and engages in scores of other activities that directly and immediately affect the private sector."

Thus, the government is looked to as holding the key to economic development, yet its political structure (firmly entrenched in the leader's thinking) is straitjacketed with limitations on how the key is used.

The dilemma that Mexico's leaders are likely to face in the 1960's is that of inability to accelerate a lagging economic growth rate within the existing public decision-making framework. Their course must either condone economic stagnation or pave the way for marked and sudden change in the public decision-making structure. Both involve risk. The Mexican people, accustomed to significant economic advances over the last two decades, are unlikely to accept loss of economic momentum without serious protest. On the other hand, abrupt changes in the national decision-making machinery were not attained peacefully in Mexico's past history.

This brief summary cannot portray the evidence the author marshalls to support his thought-provoking conclusions. Many acquainted with the Mexican society and political structure may differ with various parts of his interpretations and conclusions. Few will deny, however, that the book deserves considerable stature among current efforts to understand the complex forces that bear on the economic development of underdeveloped countries.

Clarence A. Moore

Mexico: Revolution to Evolution—1940–1960

By Howard F. Cline. Oxford University Press, New York. 375 pages. 1962. $6.75.

IN HIS DESCRIPTION of the astounding rate of growth which Mexico has exhibited during the past two decades, Professor Cline has more than justified the eminent position he holds as a historian and an authority on Mexican affairs. His broad background has enabled him to single

out the aspects of Mexican development which have general significance.

The author covers a wide range of subjects without losing sight of the central theme of the book. His comments on regionalism and centralism, the role of the Indian, and the place of the public sector in Mexican development are particularly interesting.

However, this reviewer regrets that Professor Cline did not employ his experience and background in Mexican affairs in analytical treatment of the facts which he so prodigiously presents. In the preface the author states, "A salient feature of recent developments in Mexico is a clear demonstration that beneficial social and economic change *can* be brought about in so-called 'underdeveloped areas' while preserving and increasing political and economic democracy as defined in the New World." For those directly concerned with economic growth, an analysis of the factors which made this unusual phenomenon possible would have placed the book at the head of its field. As it stands, the book is an interesting and informative chronology of the past two decades of Mexican history.

Jane Turns

The Middle East—A Social Geography

By Stephen H. Longrigg. Aldine Publishing Company, Chicago. 291 pages. 1963. $6.95.

THE AUTHOR'S long experience in the Middle East and his thorough knowledge of its affairs are evident in each chapter of the book under review. With authority and personal feeling he presents the historical highlights of the region and discusses its current conditions. He complements a unified regional approach with discussions of the physical, political, economic, and social features of individual countries. Discussion of economic aspects is rather limited; of the 12 chapters of the book, only one is devoted to agriculture and industry, and one to oil.

But the author goes beyond a condensed presentation of the Middle Eastern panorama: He answers basic questions that are often raised about the Middle East, arrives at convincing conclusions, and clearly expresses his views on issues. One of these is whether the region has "any unity at all"; and within that, what basis is there for Arab unity? Another is whether Islam continues to play a vital role in the modern Middle East.

In the chapter on oil, the author discusses the role of oil companies in an atmosphere of intense nationalism.

Students of the Middle East will find very little in the book that is new to them. Yet they will be challenged by some of the author's conclusions and views. On the other hand, the general reader will find here an authentic source of condensed information on various aspects of the region.

Afif I. Tannous

From Prairie to Corn Belt: Farming on the Illinois and Iowa Prairies in the Nineteenth Century

By Allan G. Bogue. University of Chicago Press, Chicago. 310 pages. 1963. $6.95.

THE DEVELOPMENT of Corn Belt farming resulted from a combination of many experiences and circumstances. Allan G. Bogue has emphasized, very successfully, the individual farmer and his contribution. At the same time, this first full-scale study of the subject gives us a clear picture of the change from open prairie to a highly productive farming region.

The prairie lands themselves had distinctive features which both hindered and facilitated settlement. The settlers were as varied as the American population. Together, the land and the settlers made a new combination. The problems of settlement, of breaking the land, of deciding upon the most profitable crops, of obtaining better livestock, and of meeting the major costs of production are discussed in separate chapters. In each case, the experiences of particular farmers give sharpness and definition to the overall picture. The author has carefully searched manuscript collections throughout the Midwest for accounts of such experiences. At the same time, he has used data in the county courthouses and in the censuses to add breadth to his picture.

Several conclusions at variance with commonly accepted beliefs come from the study. Prairie farmers, for example, turned to commercial agriculture virtually from the moment they settled. There was no period of subsistence farming be-

fore they began producing for the market. Most Corn Belt farmers were prosperous during the 1880's and the 1890's. The Populist revolt was sparked by discontent from the plains, not from the Corn Belt. Life for a farm owner and operator in the Corn Belt was, by the 1890's, a good life.

This study is a major contribution to agricultural history, and a worthwhile volume for the agricultural economist who is interested either in the Corn Belt or in just how economic growth takes place.

Wayne D. Rasmussen

Selected Recent Research Publications in Agricultural Economics Issued by the U.S. Department of Agriculture and Cooperatively by the State Universities and Colleges[1]

ANDRILENAS, PAUL A. ECONOMIC ASPECTS OF SPECIFIC PATHOGEN FREE HOG PRODUCTION. U.S. Dept. Agr., Econ. Res. Serv., ERS–142, 14 pp. January 1964.

The report aims at determining the least-cost method of repopulating individual farms raising hogs and at estimating the possible financial benefits of SPF hog production compared to conventional methods. SPF hogs have more feeding efficiency than conventional hogs because the risk of two growth-retarding diseases, virus pneumonia and atrophic rhinitis, is reduced. Feed costs for SPF hogs are estimated at 22 and 27 percent lower than those for conventional hogs requiring 500 and 550 pounds of feed per hundredweight of production.

BALLINGER, ROY A., and L. C. LARKIN. SWEETENERS USED BY FOOD PROCESSING INDUSTRIES: THEIR COMPETITIVE POSITION IN THE UNITED STATES. U.S. Dept. Agr., Agr. Econ. Rpt. 48, 22 pp., illus. January 1964.

Industrial food processors are the largest users of sweeteners in the United States. Sugar is still the primary sweetener used by food processors but its position in the manufacture of a number of products is weakening, particularly in favor of corn sirup and noncaloric sweeteners. The rising price of sugar, relative to other sweeteners, is an important factor inducing food processors to look for substitutes.

BANKS, VERA J. MIGRATION OF FARM PEOPLE—AN ANNOTATED BIBLIOGRAPHY, 1946–1960. U.S. Dept. Agr., Misc. Pub. 954, 37 pp. October 1963.

More than 250 studies, papers, and articles relating to farm migration in the United States are listed. In general, items are grouped according to the geographic area to which the data relate. References are arranged alphabetically by author within each major heading.

[1] State publications may be obtained from the issuing agencies of the respective States.

BERNITZ, ALEXANDER. SUMMARY AND EVALUATION OF AUSTRIA: PROJECTED LEVEL OF SUPPLY, DEMAND, AND TRADE OF AGRICULTURAL PRODUCTS IN 1965 AND 1975 (ERS-FOREIGN-62.) U.S. Dept. Agr., Econ. Res. Serv., ERS-Foreign-56, 44 pp. December 1963.

Summarizes a report prepared by the Austrian Institute for Economic Research, Vienna, Austria. The study analyzes the past trends and projects Austria's agricultural production, consumption, and trade for 1965 and 1975. A special section dealing with implications of U.S. agricultural trade with that country is included. Selected farm products which may be supplied by the United States are specified. Methodology used for making these projections is also included.

BIRD, KERMIT. FREEZE-DRYING OF FOODS: COST PROJECTIONS. U.S. Dept. Agr., Mktg. Res. Rpt. 639, 34 pp., illus. January 1964.

Processing costs of four hypothetical but representative processing plants were studied. Plants are classified according to their daily capacities for removing water from frozen foods—4, 8, 16, and 32 tons. Major cost factors are size of plant, duration of drying cycle, and continuity of operation. Other factors are kinds of food dried, wage rates, and utility rates. Economies of size are significant in freeze-drying. For example, the 4-ton plant at full capacity has costs of 8 cents per pound of water removed; the 8-ton plant's costs average 6.7 cents; the 16-ton plant, 5.4 cents; and the 32-ton plant 4.4 cents. Dollar volume of freeze-dried foods in 1970 is projected at about $250 million.

BIRD, KERMIT. SELECTED WRITINGS ON FREEZE-DRYING OF FOODS. U.S. Dept. Agr., Econ. Res. Serv., ERS–147, 53 pp., illus. January 1964.

A collection of speeches, articles, and informal papers by the author on freeze-drying. Discussed are such aspects of the industry as: advantages and disadvantages of the process, what foods are best suited to freeze-drying, cost studies of the process, and how freeze-drying may affect other food industries. Included is a directory of food processors, equipment firms and other businesses which now process freeze-dried foods.

BROWN, LESTER R. MAN, LAND, AND FOOD—LOOKING AHEAD AT WORLD FOOD NEEDS. U.S. Dept. Agr., Foreign Agr. Econ. Rpt. 11, 153 pp., illus. November 1963.

Until recently man was able to augment the food supply largely by moving to unsettled areas and bringing new land into production. It has now become necessary to turn to an alternate method—raising yields. First, massive applications of capital will be needed—capital must be substituted for land. Second, this change implies drastic changes in technology, especially in the less developed regions. This report seeks to assess the magnitude and direction of the effort which must be made during the remaining four decades of this century if the projected population of 5 billion is to be sustained.

CABLE, C. CURTIS, JR., HARVIN R. SMITH, and ZOLON M. LOONEY. CHANGES IN QUALITY AND VALUE OF COTTON BALES AND SAMPLES DURING STORAGE. U.S. Dept. Agr., Mktg. Res. Rpt. 645, 58 pp., illus. February 1964.

Deterioration of quality of baled cotton stored in commercial warehouses sometimes results in substantial losses in market value and creates added risks for merchants and mills. This study shows that deterioration of cotton grown in relatively dry areas can be reduced by storing it where it is grown rather than in more humid areas. Also, extra samples drawn at the time bales are placed in storage will accurately reflect changes in grade and value of the bales for up to 6 months if the samples are stored under the same conditions as the bales. Drawing extra original samples can substantially reduce the cost of resampling after storage.

EGBERT, ALVIN C., and EARL O. HEADY. REGIONAL ANALYSIS OF PRODUCTION ADJUSTMENTS IN THE MAJOR FIELD CROPS: HISTORICAL AND PROSPECTIVE (AN APPLICATION OF SPATIAL LINEAR PROGRAMMING). U.S. Dept. Agr., Tech. Bul. 1294, 67 pp., illus. November 1963. (Iowa State Univ. cooperating.)

Summarizes an economic analysis of regional production adjustments that would maximize efficiency in the production of the major field crops (wheat, corn, oats, barley, grain sorghums, soybeans, and cotton). One objective of the study was to measure the size of the production-consumption imbalance or adjustment gap under conditions of 1954. Another aim was to estimate the prospective supply and demand balance in the crops considered under projected 1965 technology and increased regional efficiency of production.

ELROD, WARRICK E., JR. MONETARY EFFECTS OF FINANCING AGRICULTURAL EXPORTS THROUGH PROGRAMS UNDER TITLES I AND IV, PUBLIC LAW 480. U.S. Dept. Agr., Foreign Agr. Econ. Rpt. 12, 28 pp. November 1963.

Two methods of financing government-to-government sales of surplus agricultural commodities under P.L. 480 are analyzed. They are sales for local currency under Title I, and sales for deferred dollar payment under Title IV. The report describes some of the conditions which make one method or the other more beneficial to the recipient country and the United States.

FARNWORTH, VIRGINIA M. PRICES, MARKETING MARGINS, AND USES OF PEANUTS IN PEANUT BUTTER. U.S. Dept. Agr., Mktg. Res. Rept. 624, 25 pp., illus. December 1963.

Peanut butter is the principal food product made from peanuts. In 1961–62, of the total 4.5 pounds per person of shelled peanuts used for food, 2.5 pounds were used in making peanut butter. Sales through retail grocery stores account for nearly 65 percent of the value of U.S. peanut butter sales. In 1960–61, consumers paid an average of 41.8 cents for a 12-ounce jar of peanut butter, the size most often bought.

HAREN, CLAUDE C., and ROBERT B. GLASGOW. MEDIAN FAMILY INCOME AND RELATED DATA, BY COUNTRIES, INCLUDING RURAL FARM INCOME. U.S. Dept. Agr., Statis. Bul. 339, 136 pp. February 1964.

Contains tables showing median incomes and other data for all families and rural farm families, for all counties in each of the 50 States in 1959. A bibliography of sources of data in the tables is included.

HIEMSTRA, STEPHEN J. RISING DEPRECIATION OF ASSETS IN AGRICULTURAL MARKETING FIRMS: SOME CAUSES AND IMPLICATIONS. U.S. Dept. Agr., Agr. Econ. Rpt. 47, 51 pp., illus. December 1963.

Depreciation of assets rose steadily during 1949–59 and likely will continue to rise. Corporate agricultural marketing firms more than doubled their dollar charges for depreciating assets in the 10 years. Principal reasons for the rising depreciation of assets in relation to total receipts of firms are (1) a greater increase in the total costs of depreciable assets than in total receipts, and (2) an increase in the rate of writing off these assets.

HODGES, EARL F. LIVESTOCK-FEED RELATIONSHIPS 1909–1963. U.S. Dept. Agr., Statis. Bul. 337, 49 pp., illus. November 1963.

This bulletin presents animal-unit numbers and livestock production units formerly published separately. In addition, it presents the high protein-consuming animal unit series; preliminary estimates of feed consumption by various classes of livestock 1960–63; and estimates of feed grain surpluses and deficits by States for the feeding years beginning October 1, 1960, 1961, and 1962.

HOLM, HENRIETTA M., and CAROLEE SANTMYER. AGRICULTURE IN TUNISIA: ORGANIZATION, PRODUCTION, AND TRADE. U.S. Dept. Agr., Econ. Res. Serv., ERS–Foreign–67, 36 pp., illus. February 1964.

Tunisia is making a serious attack on its agricultural problems. Redistribution of farmland takes high priority in the current 10-year program for agriculture. Gains from crop diversification and increased yield per acre

in the irrigated zones are being made. Tunisia's income from exports of olive oil, hard wheat, citrus, and other fruits and vegetables is expected to increase substantially. A more rapid rate of agricultural development is anticipated when planned land and water reforms have been implemented and institutional reforms have been made.

JOHNSON, NEIL W., and MERTON S. PARSONS. PLANNING THE FARM FOR PROFIT AND STABILITY. U.S. Dept. Agr., Farmers Bul. 1965, 32 pp., illus. December 1963.

This bulletin gives the farmer detailed information on how to take stock of his resources, choose crops and livestock enterprises, combine crops and livestock in a balanced farm plan, and develop his land on both a year-to-year and longtime basis. Also included is a full chapter on other publications and personal assistance programs which can assist the farmer in his planning.

KLEIN, JACK E., and LEO R. GRAY. DRIVE-IN DAIRIES IN CENTRAL CALIFORNIA. U.S. Dept. Agr., Mktg. Res. Rpt. 636, 11 pp., illus. December 1963.

Drive-in dairies increased their total share of Class I milk sales in Central California from less than 2 percent in 1957 to over 6 percent in 1962. Future gains for the drive-ins will depend largely upon the extent of competition offered by retail grocers and other market outlets. Relaxation of pricing regulations to permit retail grocers to sell milk at similar prices to those of drive-ins could retard growth in the share of the market obtained by drive-ins.

LIBBIN, SUSAN A. CONTRIBUTION OF PUBLIC LAW 480 TO DEVELOPMENT OF THE GREEK ECONOMY: A PRELIMINARY REPORT. U.S. Dept. Agr., Econ. Res. Serv., ERS–Foreign–66, 40 pp., illus. January 1964.

Since the end of World War II, the United States has supplied most of Greece's imports of grains, vegetable oils, and dairy products, first under UNRRA, the Marshall Plan, and the Mutual Security Program, and later under the P.L. 480 Title I and Title III programs. Title I imports of feed grains enabled Greece to expand its livestock production, and imports of soybean oil have relieved temporary shortages during bad olive crop years. The future market for U.S. agricultural products in Greece will depend upon growth in the Greek economy, continuation of a P.L. 480 program, and competition from other exporting countries.

MANLEY, WILLIAM T., W. FRED CHAPMAN, JR., and HAROLD B. SORENSON. COMPETITIVE PRACTICES IN MARKETING FLORIDA AND TEXAS FRESH GRAPEFRUIT. U.S. Dept. Agr., Mktg. Res. Rpt. 629, 19 pp. October 1963. (Fla. and Tex. Agr. Expt. Sta. cooperating.)

Commercial production of grapefruit in the United States is limited to Arizona, California, Florida, and Texas. Freeze disasters in Texas and Florida during the past two decades have led to instability in national grapefruit production. This study provides information to assist citrus producers and marketing agencies in Florida and Texas in making long-run production and marketing decisions.

NIKOLITCH, RADOJE. OUR 100,000 BIGGEST FARMS: THEIR RELATIVE POSITION IN AMERICAN AGRICULTURE. U.S. Dept. Agr., Agr. Econ. Rpt. 49, 28 pp., illus. February 1964.

Based mainly on information from the censuses of agriculture for 1929–59, this report shows that an increasing proportion of total sales of farm products is coming from farms with $40,000 or more of marketings. It presents the findings of a study of concentration of food and fiber production on a decreasing number of farms during 1939–59, with special reference to farms with sales of $40,000 or more. There were 102,000 such farms in the United States in 1959. A second objective of the study was to determine the relative importance of these largest farms in agriculture as a whole and in various regions.

POWELL, JULES V. THE PECAN NURSERY INDUSTRY—STRUCTURE AND ECONOMIC ASPECTS. U.S. Dept. Agr., Agr. Econ. Rpt. 44, 18 pp. October 1963.

Major problems of the pecan industry include lack of information on numbers of pecan trees and the amounts of pecans that will be produced each year. The purpose of this report is to determine trends in planting pecan trees in the years ahead. Most of the nurseries that grow and sell pecan trees are in Florida, Alabama, Texas, and Oklahoma. The largest nurseries, however, are in Mississippi, Florida, and New Mexico.

RODEWALD, GORDON E., JR., DONALD K. LARSON, and D. C. MYRICK. DRYLAND GRAIN FARMS IN MONTANA—HOW THEY STARTED, GROWTH, AND CONTROL OF RESOURCES. Mont. Agr. Expt. Sta., Mont. State Col., Bul. 579, 47 pp., illus. July 1963. (Econ. Res. Serv. cooperating.)

Data from a sample of farmers for two areas in Montana were used to determine how dryland grain farmers gain control of land and accumulate capital. From 1910 to 1960, increased labor productivity has made it necessary for farmers to acquire more land in order to fully employ their resources. Capital requirements for those entering or remaining in farming have increased.

SCHWARZWELLER, HARRY K. SOCIOCULTURAL ORIGINS AND MIGRATION PATTERNS OF YOUNG MEN FROM EASTERN KENTUCKY. Univ. Ky. Agr. Sta. Bul. 685, 29 pp., illus. December 1963. (Econ. Res. Serv. cooperating.)

Job opportunities for young men in eastern Kentucky are limited, resulting in a great stream of out-migration of youths, especially to industrial areas in the Ohio Valley. Key questions are, therefore, what happens to these young people after they leave school, and are youths who fail to complete high school at a disadvantage in the labor market? This report describes the sociocultural origins, background characteristics, migratory patterns, and residential mobility aspirations of the study population.

SHARPLES, JERRY A., and J. ROBERT TOMPKIN. THE EFFECT OF THE 1961 FEED GRAIN PROGRAM ON WEST-CENTRAL OHIO FARMS. Ohio Agr. Expt. Sta., Wooster, Res. Bul. 947, 28 pp., illus. September 1963. (Econ. Res. Serv. cooperating.)

In 1960 there were 71.6 million acres of corn harvested for grain in the United States. The feed grain program was in effect in 1961 and acreage of corn for grain was reduced to 58.7 million acres. Ohio placed 1 million acres in the program. Corn yields increased from 1960 to 1961 so that much of the effect of the acreage reduction was offset.

SMITH, HUGH M., and ROBERT E. FRYE. HOW COLOR OF RED DELICIOUS APPLES AFFECTS THEIR SALES. U.S. Dept. Agr., Mktg. Res. Rpt. 618, 11 pp., illus. February 1964.

A study of customer buying response to the color of Red Delicious apples showed that retail sales of highly colored apples (from 75 to 100 percent good red color) were significantly greater than sales of partly red apples (50 to 75 percent good red color). Sales of highly colored and partly red apples displayed together were less than sales of highly colored apples but more than those of partly red ones when each color was displayed separately.

STONER, JOHN E., and CATHERINE F. SIFFIN. A SELECTED BIBLIOGRAPHY ON INTERLOCAL GOVERNMENTAL COOPERATION, INCLUDING REFERENCES TO RURAL AREAS. U.S. Dept. Agr., Misc. Pub. 958, 40 pp. February 1964.

The bibliography is part of a study of cooperation among local governments in rural areas. Information about materials on this topic has not previously been readily available. Items listed includes articles, public documents, research reports, proceedings, and unpublished works.

STROHBEHN, ROGER W. OWNERSHIP OF RURAL LAND IN THE SOUTHEAST. U.S. Dept. Agr., Agr. Econ. Rpt. 46, 43 pp., illus. December 1963.

Landowners chosen by a probability area sample in the Southeast were interviewed. Although 98 percent of all owners were individuals, they owned only 77 percent of the rural land. Only about 2 percent of all owners were corporations, but they owned 18 percent of the rural land. The report describes such items as characteristics of owners, acreages of various kinds of land owned, method of land acquisition, ownership rights, land use, and plans for land transfer.

TSU, SHELDON, and ERNEST KOENIG. ITALIAN AGRICULTURE: PROJECTIONS OF SUPPLY AND DEMAND IN 1965, 1970, AND 1975. U.S. Dept. Agr., Econ. Res. Serv., ERS-Foreign-68, 46 pp. January 1964.

Projected population increases and expected dietary improvements suggest that Italy's demand for farm products will expand much faster than domestic production during 1965–75. Although crop yields will be higher due to technological advances, total crop area is expected to remain about the same. U.S. exports of cotton and hides and skins to Italy are not expected to change. Exports of corn, soybeans, and tobacco are expected to increase substantially.

UNIVERSITY OF MINNESOTA. EQUILIBRIUM ANALYSIS OF INCOME-IMPROVING ADJUSTMENTS ON FARMS IN THE LAKE STATES DAIRY REGION, 1965. Minn. Agr. Expt. Sta., Tech. Bul. 246, 56 pp., illus. October 1963. (Ill., Iowa, Mich., and Wis. Agr. Expt. Stations and Econ. Res. Serv. cooperating.)

This report presents the major assumptions, analyses, and results of a study of profitable adjustments in Lake States dairying. Supply response is based on an income-maximizing linear programming analysis of typical farms in 80 farm strata. The supply relations obtained project income-improving adjustments that could be made in crop and livestock enterprises within the resource limitations of farm firms.

U.S. DEPARTMENT OF AGRICULTURE. SOVIET AGRICULTURE TODAY—REPORT OF THE 1963 AGRICULTURE EXCHANGE DELEGATION. U.S. Dept. Agr., Foreign Agr. Econ. Rpt. 13, 82 pp., illus. December 1963.

This is a report on the recent visit by Secretary of Agriculture Orville L. Freeman and his exchange group to the U.S.S.R. The team's report attempts to bridge the statistical gaps on some phases of agriculture by drawing on local data, personal observation, and experience gained from previous visits and studies. The central agricultural problem in the Soviet Union in recent years has been that of expanding production of food and fiber. There were substantial increases from 1954 to 1958, but, since 1958, increases in crop and livestock production have been slight. Because of poor crops in 1963, the Soviet Union imported large quantities of wheat.

U.S. DEPARTMENT OF AGRICULTURE. THE 1964 WORLD AGRICULTURAL SITUATION. U.S. Econ. Res. Serv. and Foreign Agr. Serv., Foreign Agr. Econ. Rpt. 14, 37 pp., illus. December 1963.

The analysis of the 1963–64 world situation in terms of production, supply and trade, and price trends indicates a rise in world agricultural production in the coming year slightly above the level reached in 1963. Associated with this are a record movement of farm products in world trade and a slight rise in world prices. A breakdown of important agricultural trends in the Western Hemisphere, Western Europe, Eastern Europe, West Asia, Africa, and the Far East and Oceania shows what might happen in these key areas in 1964.

U.S. ECONOMIC RESEARCH SERVICE. USSR FARM PRODUCTION IN 1963. U.S. Dept. Agr., ERS-Foreign-70, 6 pp. January 1964.

Agricultural output in the Soviet Union during 1963 fell sharply below the level of 1962 and was lower than in 1958, the base year of the present Seven Year Plan. A dry fall, and a severe winter followed by one of the worst droughts of the century, were the immediate causes for 1963's shortfalls in production and supplies.

U.S. CROP REPORTING BOARD. CROP PRODUCTION: 1963 ANNUAL SUMMARY—ACREAGE, YIELD, PRODUCTION, BY STATES. U.S. Dept. Agr., Statis. Rptg. Serv., CR–PR 2–1(63), December 1963.

U.S. CROP REPORTING BOARD. CROP VALUES: SEASON AVERAGE PRICES RECEIVED BY FARMERS AND VALUE OF PRODUCTION, 1962 AND 1963. U.S. Dept. Agr., Statis. Rptg. Serv., CR–PR 2–1–1(63), December 1963.

U.S. CROP REPORTING BOARD. VEGETABLES—FRESH MARKET: 1963 ANNUAL SUMMARY—ACREAGE, PRODUCTION, AND VALUE OF PRINCIPAL COMMERCIAL CROPS. U.S. Dept. Agr., Statis. Rptg. Serv., Vg 2–2(63), December 1963.

U.S. CROP REPORTING BOARD. VEGETABLES—PROCESSING: 1963 ANNUAL SUMMARY—ACREAGE, PRODUCTION, AND VALUE OF PRINCIPAL COMMERCIAL CROPS. U.S. Dept. Agr., Statis. Rptg. Serv., Vg 3–2(63), December 1963.

U.S. CROP REPORTING BOARD. MILK PRODUCTION AND DAIRY PRODUCTS: ANNUAL STATISTICAL SUMMARY, 1963. U.S. Dept. Agr., Statis. Rptg. Serv., Da 3(64), February 1964.

U.S. CROP REPORTING BOARD. SEED CROPS: 1963 ANNUAL SUMMARY—ACREAGE, YIELD, PRODUCTION, SEASON AVERAGE PRICE, AND VALUE OF PRODUCTION. U.S. Dept. Agr., Statis. Rptg. Serv., SeHy 1–3(63), December 1963.

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